Southern California Giant Reed Removal Analysis and Management Direction For the Angeles National Forest

Prepared for:
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Angeles National Forest
Supervisors Office
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May 1999

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PURPOSE

The purpose of this report is to provide recommendations as to the most effective giant reed (*Arundo donax*) eradication program to be used on National Forest System lands. These recommendations are based on information from three Southern California giant reed removal projects of varying scope and methods.

The goal of this report is to provide information useful for planning programs to control the exotic plant, giant reed. Control of giant reed will enhance endangered species habitat, increase native flora and fauna habitat, improve water quantity and quality, decrease biological pollution in rivers, estuaries and beaches, and decrease fire threat in riparian areas.

BACKGROUND

Giant reed is an invasive, exotic member of the grass family, related to bamboo, that has completely infested many native riparian areas in Southern California during the last 25 years. This is an especially critical issue since over 95% of the historic riparian habitat in the southern part of the state has been lost to agriculture, development, flood control and other human-caused impacts (Faber et al. 1989, Jensen et al 1989).

Historically, giant reed was first introduced to Southern California over 100 years ago by Spanish settlers who cultivated the plant for many uses, including erosion control in ditches. It was also planted to serve as a food source for pigs and goats, and as thatch roofing for homes (The Nature Conservancy 1996).

Giant reed, which reproduces from rhizomes, can grow up to two inches per day (Hoshovsky 1988) reaching an ultimate height of 25 to 30 feet, thus effectively out-competing native vegetation for space, sunlight, and water. Due to the aggressive and effective nature of giant reed, it is problematic for 5 reasons, including: 1) loss of native flora and fauna habitat, 2) elimination of endangered species habitat, 3) reduction of water quantity and quality, 4) increase in biological pollution in rivers, estuaries, and beaches, and 5) increase threat of fire in riparian areas.

1) Elimination of Native Flora and Fauna Habitat

The general overall loss of riparian habitat is due to the ability of giant reed to out compete

native habitat. Although, giant reed stalks do produce large amounts of seed annually, the seeds are seldom viable, so nearly all reproduction is done vegetatively, through the spread of the rhizomes. Over time, these rhizomes will form dense root masses which can extend over several acres. This species is well adapted to the high disturbance dynamics of riparian systems as it spreads primarily vegetatively. Flood events often break up clumps of giant reed and spread the pieces downstream where fragmented stem nodes and rhizomes can take root and establish new plant colonies (Bell 1994). There can be no clear area of open soil for native seedlings to become established if the soil is densely packed with giant reed rhizomes.

To further add to the competitive edge, giant reed grows up to 30 feet in height, completely shading all riparian vegetation of lessor height, such as mulefat (Baccharis salicifolia), willow species (Salix sp), all forbs, and grasses. Only the tallest cottonwood (Populus) trees can survive a giant reed infestation and even they don't reproduce well in these conditions. Not only are the crowns surrounded by giant reed, to the point that only the very top of the trees are exposed to sunlight, but there is no place for cottonwoods to establish new seedlings. In addition, there may also be nutrient and water depletion of the soil.

2) Elimination of Endangered Species Habitat

Giant reed is such an effective direct competitor against native riparian vegetation that these natural habitats are eventually, and completely type converted to 100% giant reed stands resulting in a serious and detrimental effect on many threatened, endangered and sensitive species (T E & S species). Some of the species at risk are least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Emipidonax traillii extimus*), yellow warbler (*Dendroica petechia morcomi*), arroyo southwestern toad (*Bufo microscaphus californicus*), Santa Ana speckled dace (*Rhinichthys osculus*), unarmored threespine stickle-back (*Gasterosteus aculeatus williamsoni*), Quino checkerspot (*Euphydryas editha quino*), Nevin's barberry (*Berberis nevinii*), and slender- horned spine-flower (*Dodecahema leptoceras*).

For many of the bird species the most serious problem is that giant reed eliminates willow, mulefat, sycamore and cottonwood habitats. These types of native vegetation provide nesting habitat and food material. For the fish and amphibians, giant reed reduces the water quality and water quantity and therefore reduces their habitat. Structurally, giant reed is composed of mostly vertical canes, not branches like native vegetation, so the stream is not shaded as much

by giant reed, causing water temperatures to increase. Also giant reed transpires more than native vegetation, so there is less water in the stream for in stream flow needs. For most sensitive plants, the loss of sunlight and space is the cause of their elimination.

3) Reduction in water quality and quantity

Giant reed reduces water quality by increasing water temperature, reducing dissolved oxygen content and increasing sedimentation and soil erosion. As a result, streams dominated by giant reed tend to have warmer water temperatures and lower diversity of aquatic animals (Bell 1994, Iverson 1994). Giant reed destabilizes streambanks because the shallow root system is often undercut during high stream flows (O'Hare, 1999 per. com.).

Mark Iverson, Physical Engineer with the City of Riverside, in his paper entitled, <u>Effects of *Arundo Donax* on Water Resources</u>, states, "Not only does giant reed out compete native plants, it uses about three times as much water as they do. There are no specific studies on the evapotranspiration rates of giant reed. Horticulture experts, however, estimate that giant reed evaporates water at approximately the same rate as rice. This means that every acre of giant reed uses about 5.62 acre-feet of water per year. Native species use only about one third this amount, 1.87 acre-feet per year. The water lost to evapotranspiration is water that would otherwise be available for in-stream flow needs, reservoirs, lakes and groundwater recharge and ultimately drinking water supplies."

Using these rates, it is calculated that the giant reed in the Santa Ana River alone, transpires 56,200 acre-feet of water every year. If untreated replacement water was purchased from the Metropolitan Water District, the cost of 56,200 acre-feet of water would be $18,000,000. and would serve about 280,000 people. If all giant reed areas in the Santa Ana River were replaced with native vegetation, only 18,700 acre-feet of water would be transpired. This savings could serve 190,000 people and save $ 12,000,000. in water cost (Iverson 1994). It is unknown what the cost of water will be in the future, but demand and cost will increase.

4) Biological Pollution in Beaches, Rivers, Estuaries, Lakes and Reservoirs

Giant reed rhizomes are extensive but not deep, so they are easily mobilized during flood

events. Flood waters, sediment and debris build up behind dense stands of giant reed, easily toppling the stands and uprooting the rhizomes. The rhizomes, soil, giant reed stalks, inorganic debris, and other vegetation are then moved along the channel or riparian area in a large debris mass that can threaten or destroy bridges and other in stream structures and create huge debris piles on beaches, estuaries and other coastal wetlands. This commonly occurs in Long Beach along the shores of San Pedro Bay, where the beach is situated between the mouth of the Los Angeles and the San Gabriel Rivers. In 1993, the flood waters left an estimated 7,000 tons of organic debris (mostly giant reed) to be removed from beaches and marinas in Long Beach (Douce' 1994).

5) Increase Fire Threat

The increase threat of fire due to giant reed is problematic for two reasons. First, giant reed is highly flammable throughout most of the year, and it appears highly adapted to extreme fire events (Bell 1994). Also, pure stands of giant reed produce twice, sometimes three times as much biomass as native vegetation (Scott 1994), thereby greatly increasing the fire risk. Fire frequency and intensity is increased with giant reed which will result in a permanent conversion of giant reed, because it is fire adapted. These two combinations are very effective in quickly type converting a partial giant reed invaded native habitat, to 100% giant reed cover since giant reed is not only highly flammable but it also recovers quickly from fire by sending up new sprouts from the rhizomes. Native riparian vegetation is not fire adapted because natural wildfires do not regularly occur in healthy riparian systems. Also, an increased fire intensity threatens roads, bridges, private residence and wildlife habitats because of increased flooding and debris movement within stream channels following a fire.

SOUTHERN CALIFORNIA ARUNDO ERADICATION PROJECTS

Giant Reed (Arundo Donax) eradication and riparian management; Van Buren Units, Santa Ana River

Monitoring and Progress Report #4, Giant Reed (Arundo donax) eradication and riparian management. Van Buren Units Santa Ana River. November 1994 to February 1995. Prepared for the: Santa Ana River Interagency Habitat Recovery Project. By: Shelton Douthit Riverside Land Conservancy 5995 Brockton Ave., Suite A-1, Riverside, CA 92506.

Goal

The goal of the Van Buren Project is the removal of giant reed from 22.5 acres of river terrace, the maintenance and permanent elimination of giant reed within that 22.5 acres and the establishment and/or recovery of native cottonwood/willow forest within the unit (Douthit 1995).

The project location of this project is in Riverside County above in Van Buren Bridge in the Santa Ana River. As of the Summer of 1992, this site was almost entirely dominated by giant reed, and it burned twice in the previous two years. This increase in fire frequency not only threatened near by homes and businesses, but it also jeopardized the structural stability of the Van Buren Bridge. The stream channel was impacted from increased flooding and debris movement following the fire.

Methods and Time Line

For this project, only foliar spray treatments were used. Spraying was carried out with helicopter, vehicle mounted spray equipment, and backpack applications of Rodeo® in or near wetlands. Round Up® was used at 100 feet or more away from areas of surface water. Spray concentrations of 5% to 8% were used.

Spraying activity began in March 1993, with broadcast treatment of giant reed using 57.5 gallons of Rodeo applied by a helicopter, immediately followed by ground treatments on areas that could not be reached by air. Both methods resulted in a 65 - 75% kill of standing giant reed.

Two months later in May 1993, ground crews began removing dead standing giant reed. A second aerial application of herbicide occurred in July 1993. By August 1993, it was believed that there was a 80 - 85 % kill of the remaining stands of giant reed. At the end of that month, a herbicide spot treatment was used on resprouts using backpack sprayers and vehicle mounted spray equipment.

By February 1994, all giant reed closest to the pacific railroad tracks was removed and burned. By the end of the fall 1994 all the remaining dead giant reed stalks were collected. Again in April 1994, treatment of resprouts had begun and was planned to continue annually as needed. The resprouts were very vigorous with 70 - 75% of the unit resprouting at a rate of 2.6 inches per week. Site maintenance involved the use of a three-person site maintenance team in the treatment of resprouting giant reed with herbicide and it continued on a weekly basis throughout the Fall and Winter of 1995.

Also during January 1994, a revegetation effort was begun, which involved the collection of willow and mulefat cuttings, one year old saplings and planting of 1,088 riparian species. The collection site was roughly one mile down stream, and it reflected the historic gene pool found at the planting site.

Results and Analysis of Giant Reed (Arundo Donax) eradication and riparian management; Van Buren Units, Santa Ana River

Van Buren Units successfully eliminated giant reed from 13 acres closest to the Pacific railroad tracks (Frandsen per comm 1998). However, below the cleared area, on the remainder of the area, giant reed returned as the dominate plant species. It is likely that if action is not taken again, the project site will once again be dominated by dense, 100% giant reed stands.

The most serious problem for this eradication project is that the foliar applications were applied during the giant reed growing season (March). Little or no herbicide reached the rhizomes, which must be killed for effective control. This is clear since up to 75% of the stands resprouted in April 1994 at a rate of 2.6 inches per week.

Though unknown at the time of this study, the results would have most likely been different if the foliar applications had been applied when the giant reed was in a post-flower and pre-

dormancy state. During this time, late-August to early November, the plants are actively translocating nutrients to the rhizomes in preparation for winter (The Nature Conservancy 1996).

Another prevailing assumption with this project was the belief that because the foliar area of giant reed had been killed, the entire plant was dead. The rhizomes have an enormous energy reserve to draw from and if they are not killed, the plants will invariably continue to resprout, grow, and thrive.

Santa Margarita River Exotic Plant Control Plan

Final Arundo Removal/Control and Native Wetland Establishment Plan. Prepared for: Southwest Division Naval Engineering Command and Marine Corps Base Camp Pendleton. Prepared by: The Nature Conservancy, Temecula Projects Office. 27393 Ynez Road, Suite 251. Temecula, CA 92591.

Purpose

The purpose of this eradication plan is to remove and completely eliminate 27.8 acres of giant reed from the upper most watershed of the Santa Margarita River (uninfested areas are not counted). In addition, 11 of the 27.8 acres should have greater than 50% relative cover of native wetland species. The acreage to be treated was determined by assuming the cost of control for the second and third years would be ½ the first year, the fourth and fifth years would be ⅓ the first year. The land is owned by the Fallbrook Public Utility Company.

Methods

All treatments were completed in the post-flower, pre-dormancy stage of giant reed, which generally occurs from late August to early November. The three treatments used in this project for comparison were foliar treatment, cut-stump immediate treatment (<2 minutes), cut stump delayed treatment (>3 minutes).

Foliar treatments were applied with backpack sprayers and vehicle mounted spray equipment at an application rate of 2 - 5% solution of Rodeo® to the leaves of the plant. The cut-stump

method required applying a 50 to 100% solution of herbicide to the stalks either <2 minutes or >3 minutes after the stalks were cut. Ninety percent of the treatment was cut stump; in large part because many of the densest stands had an overstory of willows and oaks and the giant reed was so tall that foliar application was not possible without overspray to the natives (Lawson 1998). Initial treatments were carried out in September 1995 with a follow up treatment for resprouts in November 1995. Resprouts were again treated in September 1996, and September 1997. Only 5% of the foliar treatments needed follow up treatments.

Three spraying apparatus used for this project were a truck-based sprayer, used next to roads; ATV-based sprayers used in open soft bottom areas, and backpack sprayers used when target plants were growing in small clumps interspersed with native vegetation or where access with other equipment was limited.

There were three target areas for application protocol, pure stands, mixed stands and sparse stands. Pure stands were areas of at least ¼ acre in size, with greater than 80% cover of the target species, and the preferred method of treatment was by truck or ATV sprayers using the foliar or cut/spray methods. Mixed stands were areas of at least ¼ acre with 20% to 80% cover by target species, and the preferred method of treatment was truck, ATV or backpack sprayers using the foliar or cut/spray methods. Sparse stands were areas of occasional clumps of target species less than ¼ acre in size occurring at some distance apart, and the preferred treatment method for these areas was foliar treatment by truck, ATV or backpack sprayers. If the stand structure was situated so that the work could not be done without significant over spray into adjacent to native vegetation, then only cut/stem treatment was used.

The two methods used for removal of biomass were removal and chipping of dry stalks or stacking within dry areas of the project site. Removal of biomass was only done in areas where the weed cover was so dense that it inhibited native vegetation regeneration or in areas where green vegetation was so dense that it had the possibility of creating a debris dam hazard during flood events. Chipping of dry material was the most cost effective and preferred method.

Results and Analysis of Santa Margarita River Exotic Plant Control Plan

In the first year there was a 38% to 53% decrease in giant reed cover on three transects within dense cover and over the first two years, the reduction was 43% to 59%. A fourth transect

located within the densest area of giant reed had only a 19% decrease in the first year and a 35% decrease in the second year (Giessow & Giessow 1997; Lawson 1998).

The most successful treatment required the fewest follow up application treatments of foliar spraying during the fall months. All foliar applications required one initial spray treatment; with minimal or no additional follow up spray treatments. This method had a 95% success rate with only minimal follow up herbicide applications needed within the second year after initial treatment. Giant reed, treated with the cut stump immediate method had a 33% resprout rate while the cut stump delayed treatment had a 39% resprout rate. The foliar spray treatment had a resprout rate of 5% (Giessow & Giessow 1997; Lawson 1998). It is important to note however, that while the foliar treated giant reed appeared dead, they were able to resprout within two years after the initial treatment. It is important that when applying this method, monitoring and necessary follow up treatments are conducted for several years to ensure that giant reed plants are dead.

Another reason for the success of this method, was that the scope and size of the project did not exceed the amount of funding available for a five year period of the project.

Camp Pendleton Foliar Treatment Removal Project
***Arundo donax* Foliar Treatment Removal Project. Prepared by: Natures Image Inc. 20381 Lake Forest Drive B19. Lake Forest, CA 92630 and Barden Environmental 556 S. Fair Oaks Ave 101-168. Pasadena, CA 91105.**

Purpose

The purpose of this project was not to remove giant reed over a large area but to evaluate different methods used to control and reduce giant reed. The giant reed eradication involved field test plots within Camp Pendleton, primarily the Santa Margarita River watershed and its tributaries during September and October 1997.

Methods

Removal treatments were exclusively limited to one application of foliar spray treatments to uncut, fully matured giant reed stems in clump transects during September and October 1997.

Every 15 days for two months new clump transects were treated. Each clump received one application, no further treatments were given and regrowth results were measured exactly one year later. Due to the known giant reed response to herbicide, a one year post treatment analysis was chosen to ensure the validity of the end results.

The study area was divided into forty-eight individual clump transects each containing 100% giant reed cover. The size varied in length, width and height depending on the extent of the individual clump at the transect site for a maximum size of 0.01 acres (21 x 21 feet). All clump transects and locations were randomly chosen along a 600 foot transect line.

The giant reed clumps were divided into twenty-four dry riparian habitat (R1-R24) and twenty-four dry upland vegetation habitat (U1-U24). Moist or damp riparian sites were not available at the time of the treatment. Six separate treatments were tested based on a combination of 2%, 5% chemical solution and 0%, 2% and 4% fertilizer solution. All giant reed clumps were given a one time foliar treatment with one of these chemical concentrations. All treatments were repeated every 15 days on new plots for a total of four, fifteen day treatment periods during September 1997 and October 1997. Fertilizer was added to some applications to determine if it would increase the speed of mortality of the giant reed clump transects. All giant reed clumps were hand sprayed using back pack sprayers with extended nozzles and ladders where necessary.

Results and Analysis of Camp Pendleton Foliar Treatment Removal Project

The two most successful foliar treatments were at a 5% solution of Round Up Pro ®, with no fertilizer, and a 5% solution of Round Up Pro ® with 2% fertilizer. At both rates, 12.5% of the transects within this treatment area showed signs of re-sprouting one year after treatment. Compare this to six out of eight or 75% giant reed clump transects which showed signs of re-sprouting with an application of 5% solution with 4% fertilizer.

The least successful treatments were combinations of solutions with 2% chemical solution. At both a 2% solution with no fertilizer, and a 2% solution with 4% fertilizer, a 71% of the transects showed signs of cane resprouting. This compares with 85% re-sprout of the transects which were treated with 2% chemical solution and 2% fertilizer.

The results of the Camp Pendleton study, were measured against transect regrowth, giant reed resprout per application period, regrowth by habitat type, regrowth by application rates, and soil moisture.

Transect regrowth is based on the number of individual transects that showed signs of secondary branch resprouting. There was little to no sprouting from rhizomes in any of the treatment areas, as a result, almost all regrowth in the giant reed clump transects took the form of cane resprouting due to the secondary growth of the leaf axils on the branches. The most successful treatment results were transects treated with 5% chemical solution with 0% and 2% fertilizer solution. These stalks were left standing and were not removed.

There are however, noticeable differences in giant reed re-sprouting based on application of herbicide rates and timing (September to October). However these differences cannot be explained and show no consistent trend over time.

Furthermore, upland transects were less likely to show cane resprout verses the riparian transects. A total of 63.6% of the giant reed clump transects in the riparian habitat resprouted while only 43.4% of the clump transects in the upland habitats resprout. There are a variety of possible explanations. Considering giant reed's vegetative structure and it's extremely high ability to transpire, constant high soil moisture levels throughout the year is the most likely criteria for giant reed re-growth. This would explain the increased growth in the riparian plots and the decreased growth in the upland plots with less constant high soil moisture levels.

Another influence on giant reed growth and reproduction is soil moisture at the time of application. It is possible and highly likely that while soil moisture at the time of treatment does not affect regrowth tendencies, a constant high soil moisture level throughout the year may have a pronounced impact on the ultimate plant death at treatment areas. Soil moisture levels and giant reed clump resprouting results were random and showed no correlation.

The Recommended Treatment of Giant Reed on National Forest System Lands

Timing

The time of year most likely to produce positive results in the treatment for the elimination of giant reed is between August 1 and November 15. This is the post-flowering, pre-dormancy state when active translocation of herbicide to the rhizome roots is most likely. The minimum duration for a giant reed project is five years. The cost for the third to fifth years is considerably less than the first but funding should be considered for five years. During this time there must be careful follow up with a regular maintenance schedule to treat resprouting giant reed as well as the implementation of any restoration plans.

Methods

Rodeo®, produced by the Monsanto Corporation is a broad based spectrum herbicide and it is the only herbicide licensed to be used in wetlands and riparian areas within the United States. For areas 100 feet or more from wetlands. Other options for herbicides include Round Up®, Fusilade-DX® (fluazapop-butyl) and Post® (Sethoxidan). Round Up® is very similar to Rodeo® (same active ingredient with no surfactant), in that it is a broad base spectrum herbicide. Fusilade-DX®, and Post® are monocot specific herbicides, but they are not licensed to be used in wetlands or in riparian areas.

The most effective treatment for the control of giant reed is a foliar application of Rodeo® at 5% to 8%, applied between August 1 and November 15. As mentioned earlier, during this time, there is active translocation to the rhizome roots. Killing the root mass is the only effective method of completely eliminating giant reed from the site. However, follow up monitoring with necessary treatments must be conducted for a minimum of three years following the initial treatment to ensure that the giant reed plants are dead.

Within one to two months following the herbicide application, the leaves and stalks are brown and dry which creates an advantage for giant reed of the biomass. Since the stalks are dead and dry, they have little to no potential for resprouting. If the correct percentage of herbicide mixture is used, they can be left intact on the ground or chipped in place for mulch. To promote native revegetation, mulch should not be deeper than 4 inches and should be placed on site no

later than mid-winter so additional native seeds that wash in during winter storms have an opportunity to sprout in the spring.

The cut/stem method is not as effective and requires more personnel than the foliar method. This method also requires careful timing since the herbicide must be applied one to two minutes after the stems have been cut. This treatment is best applied during the post -flowering to the pre-dormant stage which occurs from August 1 to November 15. Personnel time is greater than the foliar application method, and more herbicide is used in the cut/stem method on the overall project. However, it is still the best method to use when the giant reed is interspersed with native vegetation where overspray from herbicides will likely result in harm or death to the native vegetation.

The cut/spray method is used when the stems are cut and re-sprayed at a later date. This method is best summed up by The Nature Conservancy in their report to the U.S. Army Corps of Engineers entitled Control and Management of Giant Reed (*Giant reed donax*) & Saltcedar (*Tamarix spp.*) in the Waters of the United States and Wetlands, "A popular approach to dealing with giant reed has been to cut the stalks and remove the biomass, wait three to six weeks for the plants to regrow to three or four feet, then apply a foliar spray of Rodeo® solution. The chief advantage of this approach is that less herbicide must be applied to treat the fresh growth compared with tall, established plants, and that coverage is often better because of the shorter and uniform-height plants. However, cutting of the stems result in the plants returning to growth-phase, drawing nutrients from the rootmass. As a result, there is less translocation of herbicide to the roots and less root-kill. Therefore many follow-up treatments must be made which negates any initial savings in herbicide and greatly increases the personnel costs".

Foliar applications should be applied in cases where the area of giant reed is dense and continuous and where overspray to native vegetation is minor. It is important to follow up initial applications with monitoring to ensure the rhizomes are dead since giant reed can resprout at least up to two years after initial treatment.

In situations where foliar applications will result in considerable damage and death to native vegetation the cut/stump and lastly the cut/spray methods should be used. These two methods will both require additional herbicide follow up treatments since giant reed resprouting is highly likely.

Apparatus and Safety Equipment

The preferred apparatus for use of herbicide on giant reed is a combination of a truck with tank sprayer, ATV or other similar vehicle with a tank sprayer, or a backpack sprayer. In extremely dense patches of giant reed, aerial application of herbicide concentrate with special spray apparatus that produces fine droplets should be considered. The aerial method is usually applied by helicopters and can spray large areas within one day.

The actual method chosen will depend on the density of the giant reed to be removed, and the surrounding native vegetation community. For example, if the surrounding native vegetation is dense, and large scale aerial application will cause the death of native plants then backpack or ATV spray equipment is the best option. However, if the giant reed is dense and surrounding native vegetation is sparse then the best option might be a truck with a tank sprayer or a helicopter application.

If the work is to be completed by Forest Service staff members, then an appropriate job hazard analysis needs to be completed and Cal-OSHA regulations should be followed.

Removal of the Root Mass

If the rhizome root mass dominates the site and is 2 feet or more thick, removal of the root mass should be considered depending on location, accessability and surrounding vegetation type. It is possible that breaking up the soil during rootmass removal, will encourage native plant restoration and will limit the amount of giant reed resprouting. This is only recommended in areas where giant reed is the dominate vegetation on the landscape and accessibility is not a problem. This should be avoided where roots from native trees will be damaged in the removal process. There may be the additional problem of rhizome roots being spread to previously uninfected areas.

Problematic Weeds in the Project Area

Other noxious and problematic weeds such as saltcedar (tamarisk), castor bean *(Ricinus communis)*, pampas grass (*Cortaderia selloana*), cocklebur (*Xanthium strumarium*) white sweetclover (*Melilotus alba*) and black mustard (*Brassica nigra*) should also be considered for

control at the time of treatment with additional follow up treatments. Treatments for these invasive, non-plants could range from applications of herbicide to manual removal during strategic times of the year to promote native plant regeneration.

Restoration of the Project Site

Restoration plans for the project area also needs to be addressed. If there are enough native plants with in the immediate area; natural regeneration may occur without assistance. If this is not the case or there is some question about the abundance of native species in the surrounding area, then cuttings, or seeds of willow, mulefat or other appropriate plant material can be collected from nearby sources and planted in the project area. In either case, restoration should be planned in conjunction with follow up treatments and monitoring.

Community Outreach

The overall success of removing giant reed from an entire watershed that consists of part private and part public lands will depend on community involvement. Private land owners should be informed about the destructive nature of giant reed and the effective control methods for it's removal.

Initially, upstream land owners, who have giant reed on their property should be contacted. An informational package needs to be developed in the form of pamphlets, and easy to understand research papers that clearly state the problems that giant reed causes and the benefits of it's removal. This can be handled through the Natural Resource Conservation Service (NRCS), Conservation Districts (CD), and the Forest Service.

Table 1

Summary of Three Southern California Giant Reed Removal Projects

Project Name	Initial Timing	Methods	% Solution	Root Mass	Other Weeds	Restoration	Overall Success
Van Buren/ Santa Ana River	3/1992	Foliar	9%	Not Removed	Tamarisk, Caster Bean	Active	Moderate
Santa Margarita River	9/16 to 11/15/95	Foliar	5% to 8%	Not Removed	Tamarisk, Caster Bean, Pampas Grass,	None	Excellent
Santa Margarita River	9/16 to 11/15/95	Cut/Spray Cut/Stem	5% to 8% 100%	Not Removed	Tamarisk, Caster Bean, Pampas Grass	None	Moderate
Camp Pendleton	9/1/96	Foliar	2% to 5%	Not Removed	Not Removed	None	Excellent

Table 2

Recommended Procedure for Giant Reed Removal on National System Lands

Preferred Method of Treatment					
Method	Timing	% Solution	Apparatus	Restoration	Other Weeds
Foliar	August 1 to November 15	3% to 5%	Backpack, ATV, Truck, Helicopter	Active with nearby willow and mulefat cuttings	Monitoring and removal throughout the length of project

Preferred Alternatives					
Method	Timing	% Solution	Apparatus	Restoration	Other Weeds
Cut/Stump	August 1 to November 15	100%	Chain saw, machete, backpack sprayer, truck	Active with nearby willow and mulefat cuttings	Monitoring and removal throughout the length of project
Cut/Spray	August 1 to November 15	3% to 5%	Backpack, ATV, Truck, Helicopter	Active with nearby willow and mulefat cuttings	Monitoring and removal throughout the length of project

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APPENDIX A

CAMP PENDLETON

5% Foliar Spray Treatment
One Year Later

One Year Aft Treatme... Fertilizer 0 Chemical Solution 5%

Riparian 4

Riparian 10

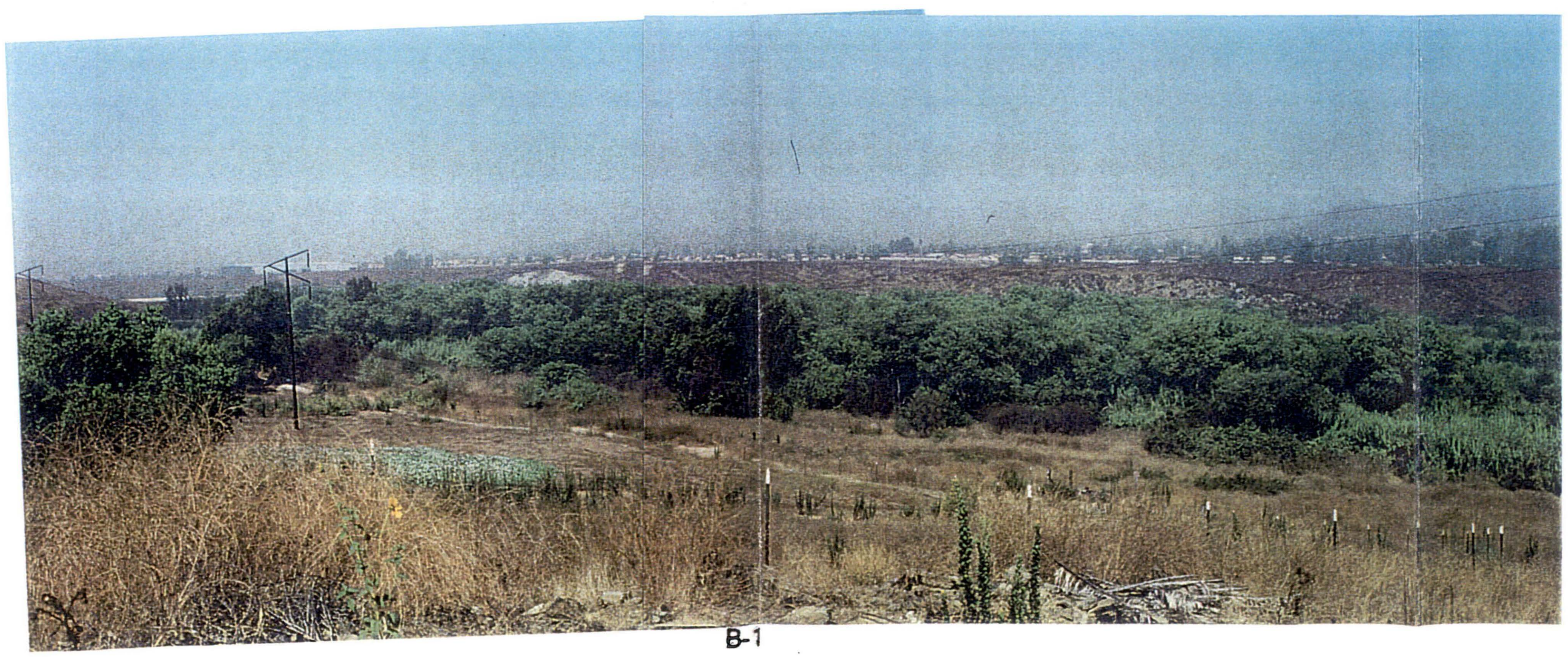
Riparian 16

Riparian 22

APPENDIX B

Santa Ana River, Van Buren Units
Arundo donax eradication project

Looking North of the Project Site



Santa Ana River, Van Buren Units
Arundo donax eradication project

Looking North of the Project Site

APPENDIX C

Santa Margarita River Project

Foliar Application Method

Cut/Stem Method

Santa Margarita River Project

Foliar Application Method

Foliar Application Method

Foliar Application Method

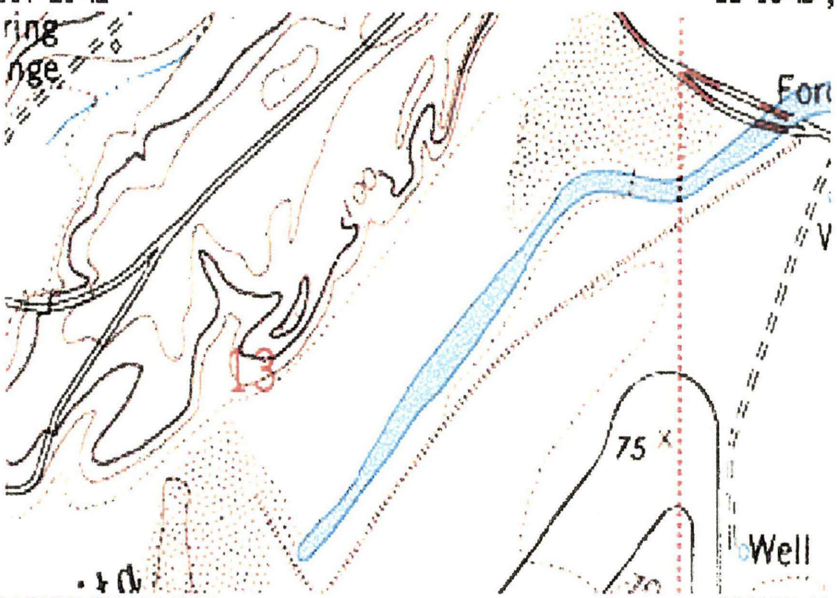
APPENDIX D

MAP OF CAMP PENDLETON PROJECT

Overview of the Camp Pendleton Project

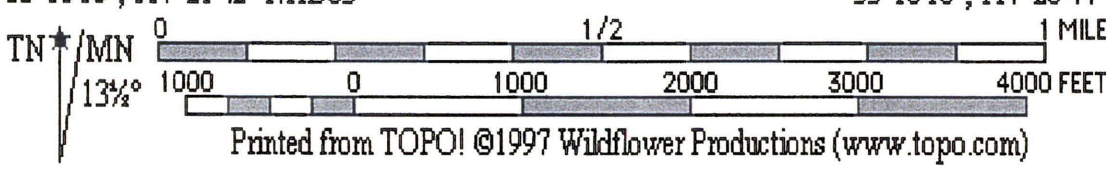
33°18'43", 117°21'42"

33°18'43", 117°20'44"



33°18'16", 117°21'42" NAD83

33°18'16", 117°20'44"



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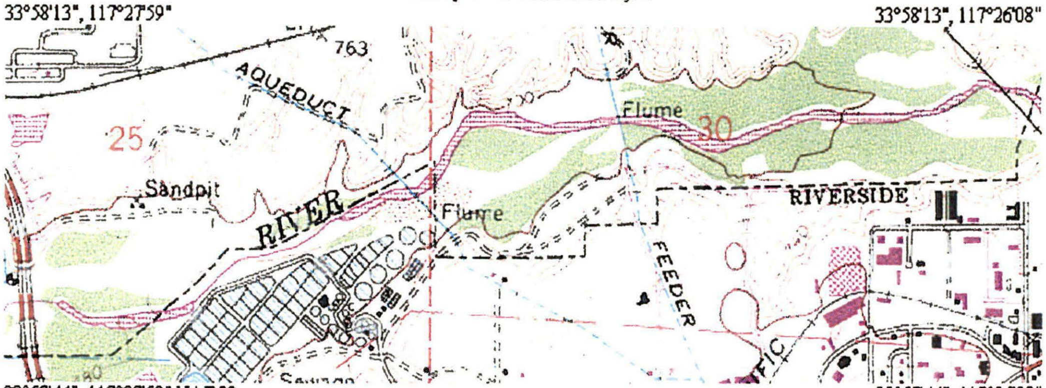
Van Buren, Santa Ana River Project Location Maps

Close-up of the Van Buren Project

33°58'13", 117°27'59" | 33°58'13", 117°26'08"



33°57'44", 117°27'59" NAD83 | 33°57'44", 117°26'08"

TN/MN 13½°

0 1/2 1 MILE

1000 0 1000 2000 3000 4000 FEET

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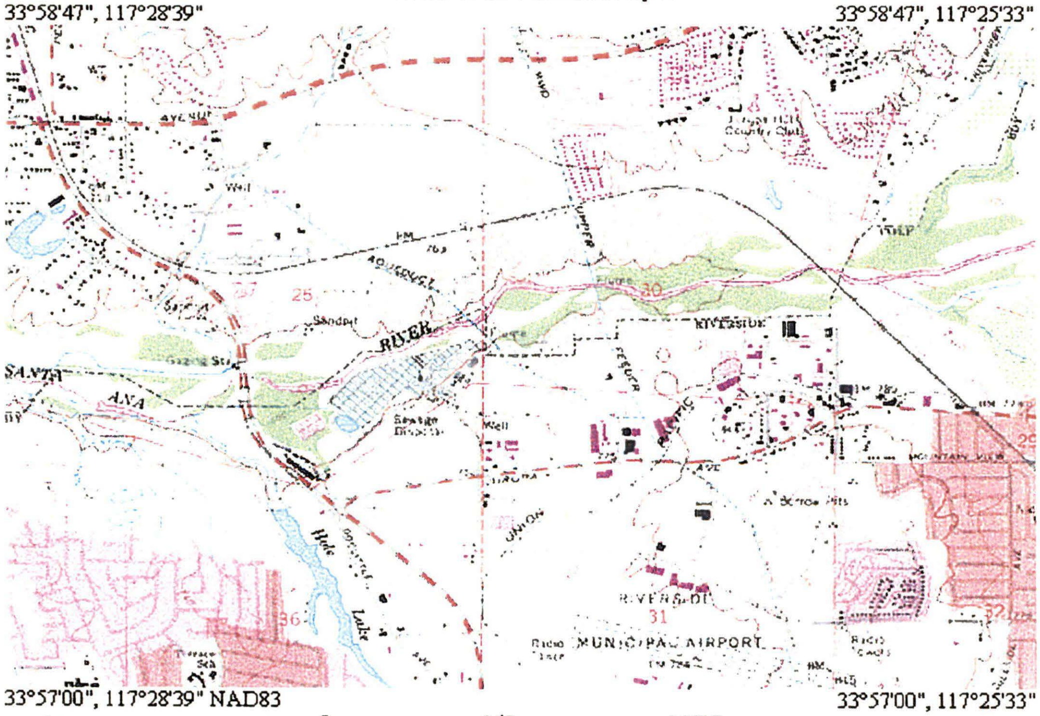
Overview of the Van Buren Project

33°58'47", 117°28'39" | 33°58'47", 117°25'33"



33°57'00", 117°28'39" NAD83 | 33°57'00", 117°25'33"

TN/MN 13½°

0 1/2 1 MILE

1000 0 1000 2000 3000 4000 FEET

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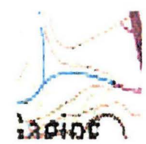
MAPS OF THE SANTA MARGARITA PROJECT

Closeup of the Santa Margarita Project

33°28'31", 117°08'28" 33°28'31", 117°08'19"



33°28'25", 117°08'28" NAD83 33°28'25", 117°08'19"

TN / MN 13½° 0 1/2 1 MILE

1000 0 1000 2000 3000 4000 FEET

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Overview of the Santa Margarita Project

33°28'43", 117°09'13" 33°28'43", 117°08'09"

33°28'04", 117°09'13" NAD83 33°28'04", 117°08'09"

TN / MN 13½° 0 1/2 1 MILE

1000 0 1000 2000 3000 4000 FEET

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